

SPEC_{inc}

In Situ Microphysical Measurements of Subvisible Cirrus in the TTL During CR-AVE



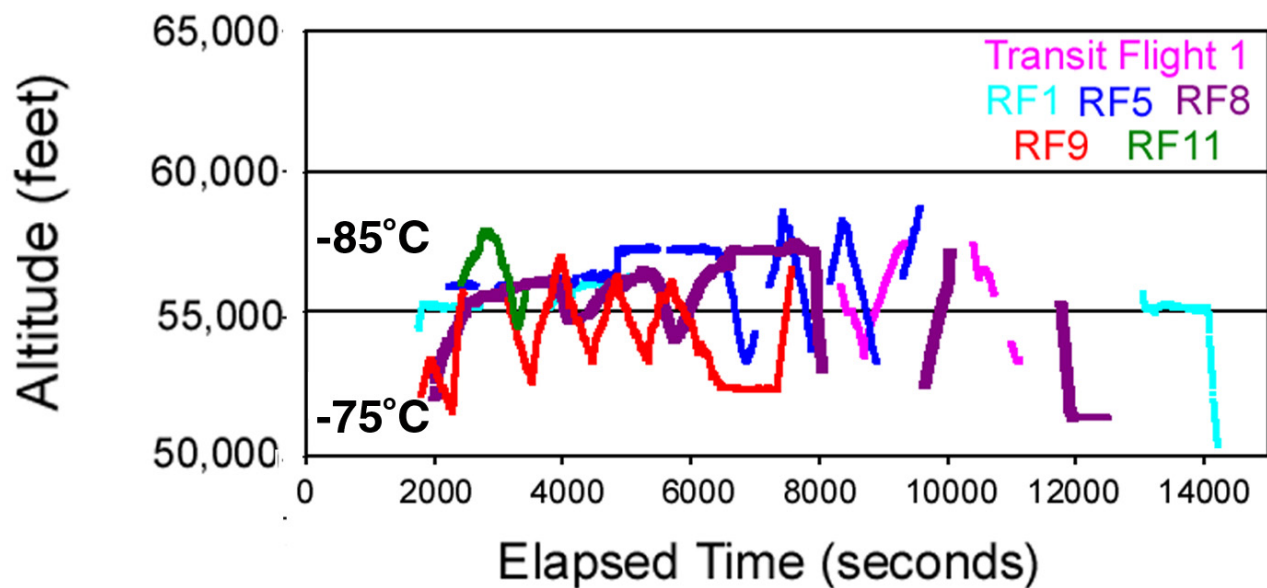
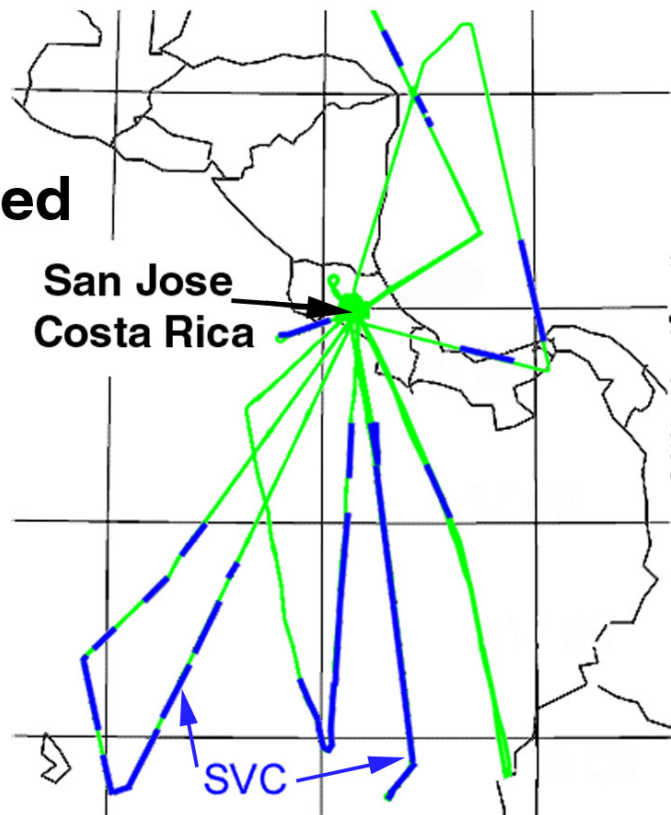
Paul Lawson

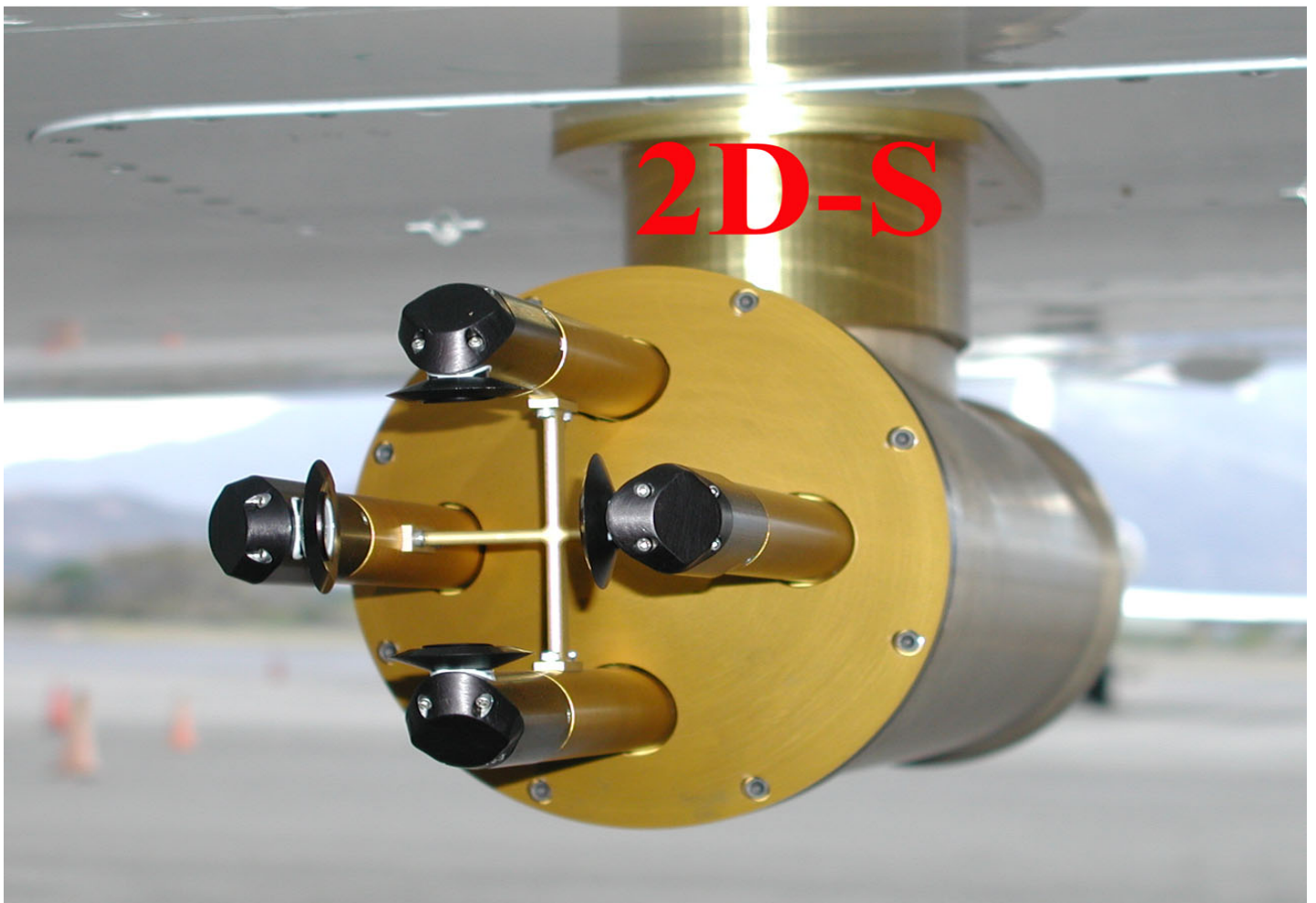
**Presented at the ATTREX Science Team Meeting
NASA Dryden Space Flight Center
25 – 27 August 2010**

ATTREX Science Issues

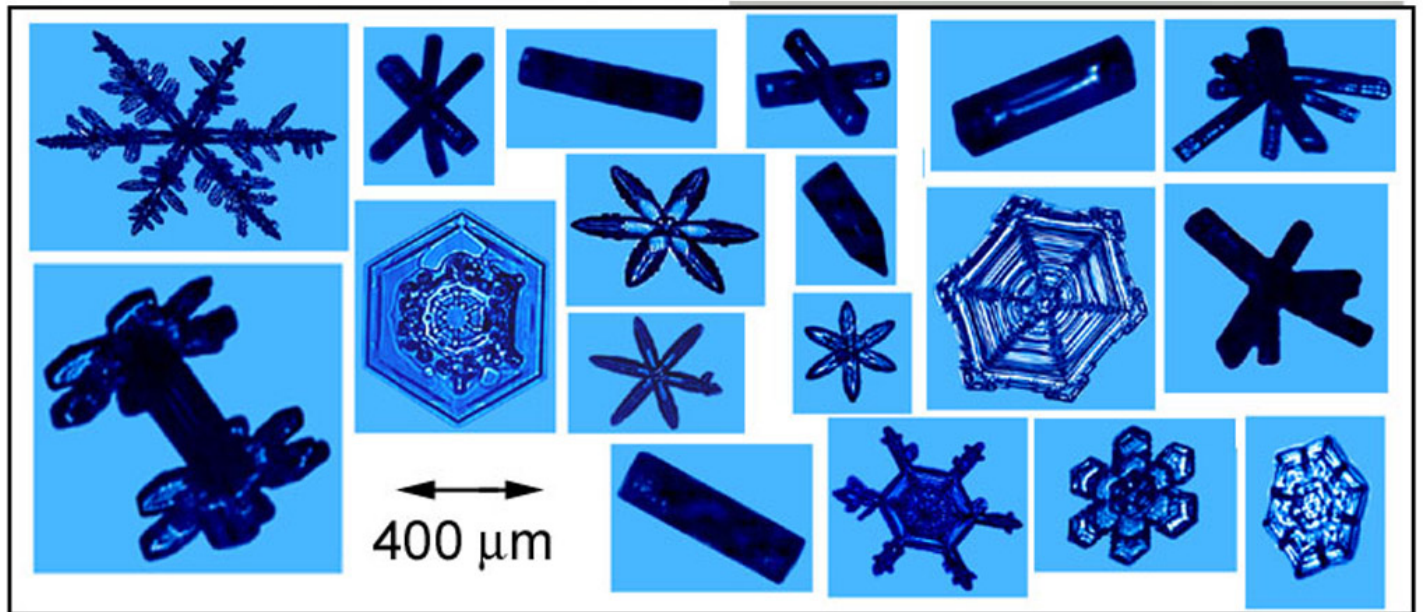
- SVC plays a potential role in controlling the water vapor concentration in the Stratosphere by freeze-drying air crossing the tropical tropopause.
- Stratospheric humidity ultimately affects polar stratospheric cloud formation, polar ozone destruction and gas-phase ozone destruction.
- SVC near the tropopause may also significantly affect the Earth's radiation budget as well as the local thermal budget near the tropopause.
- Ice Particles Observed in SVC are larger and shapes are different than Heymsfield's 1973 replicator observations.
- Model Calculations show that the Large ($> 100 \mu\text{m}$) Ice Particles Observed within 500 m of the Tropopause Require 2.5 to 4 ppm water vapor (175% to 250 RHI).

**Subvisible Cirrus
Frequently Encountered
in 500 to 1,000 m
Thick Layers from
53,000 to 58,000 ft
(-75°C to -85°C)**

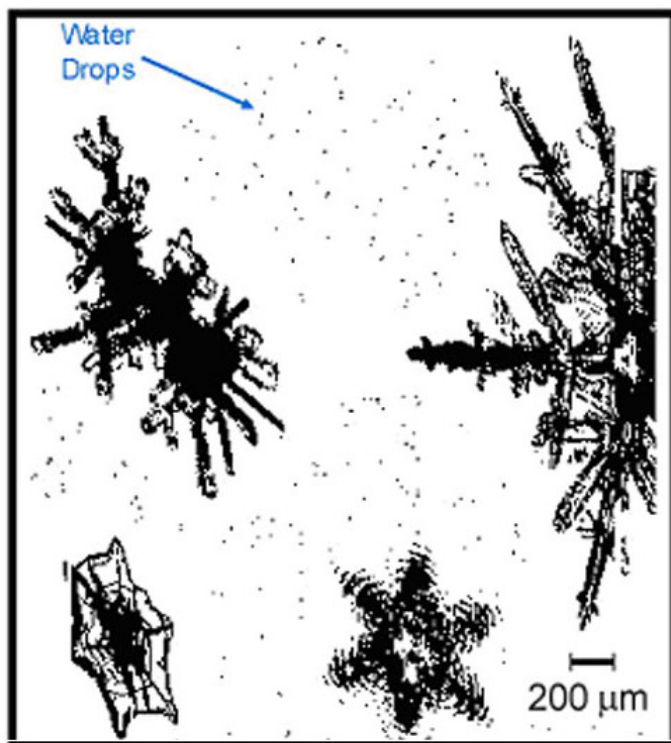




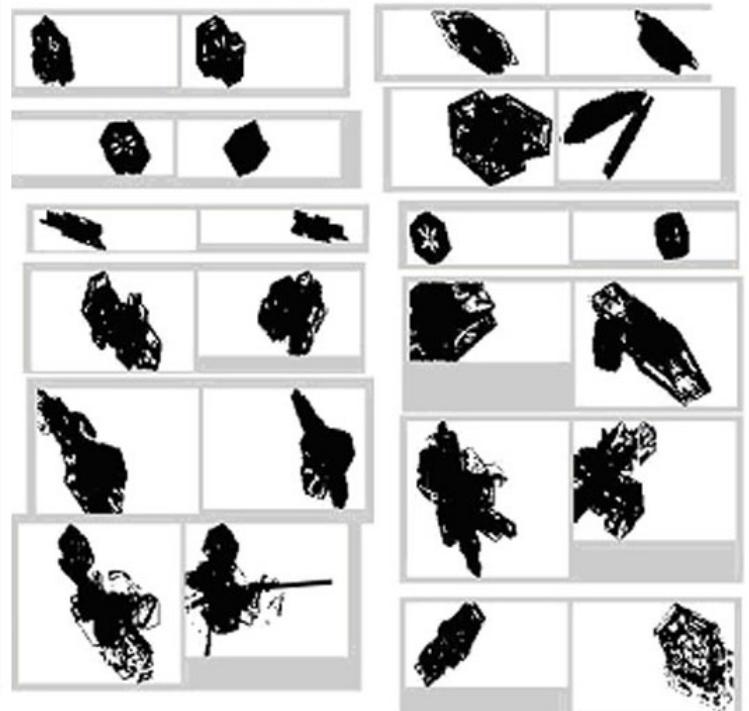
CPI Images



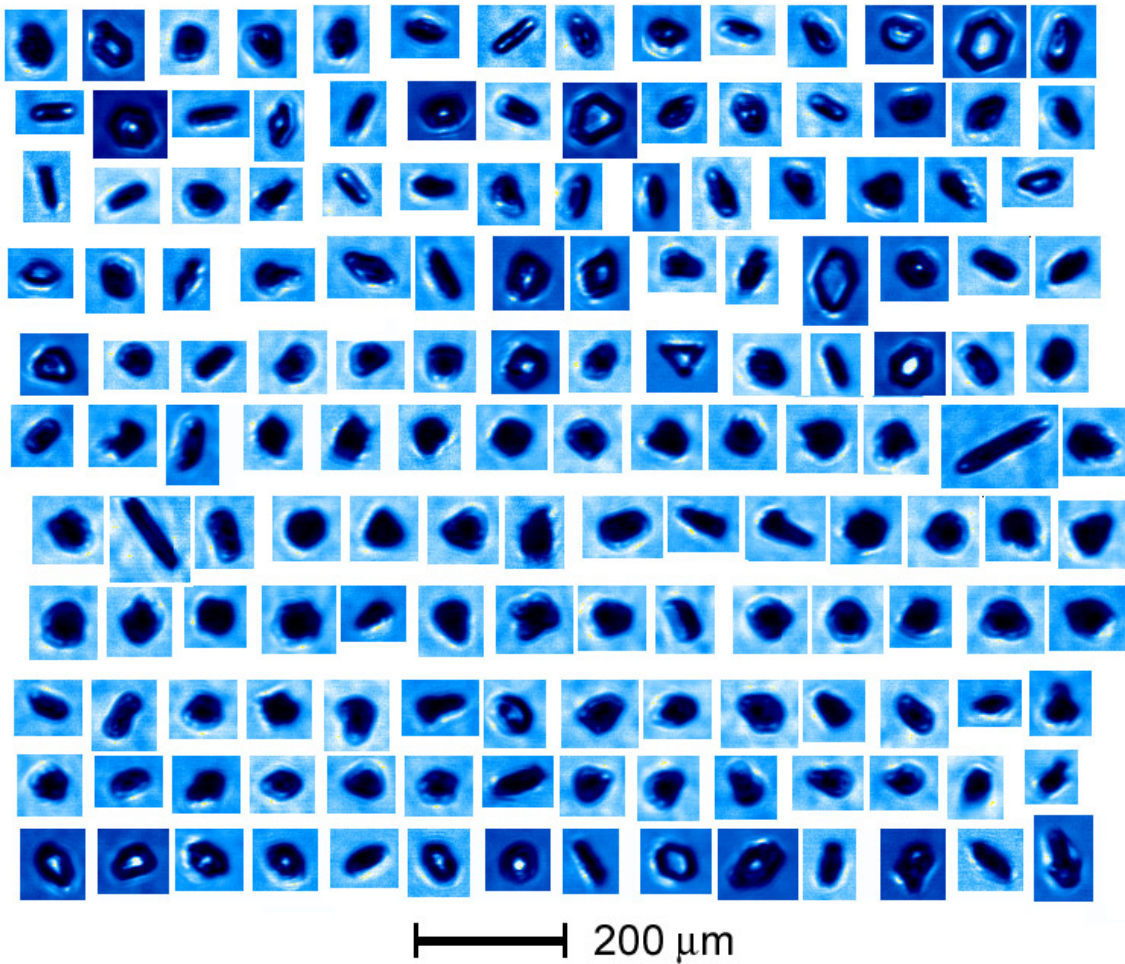
2D-S Images



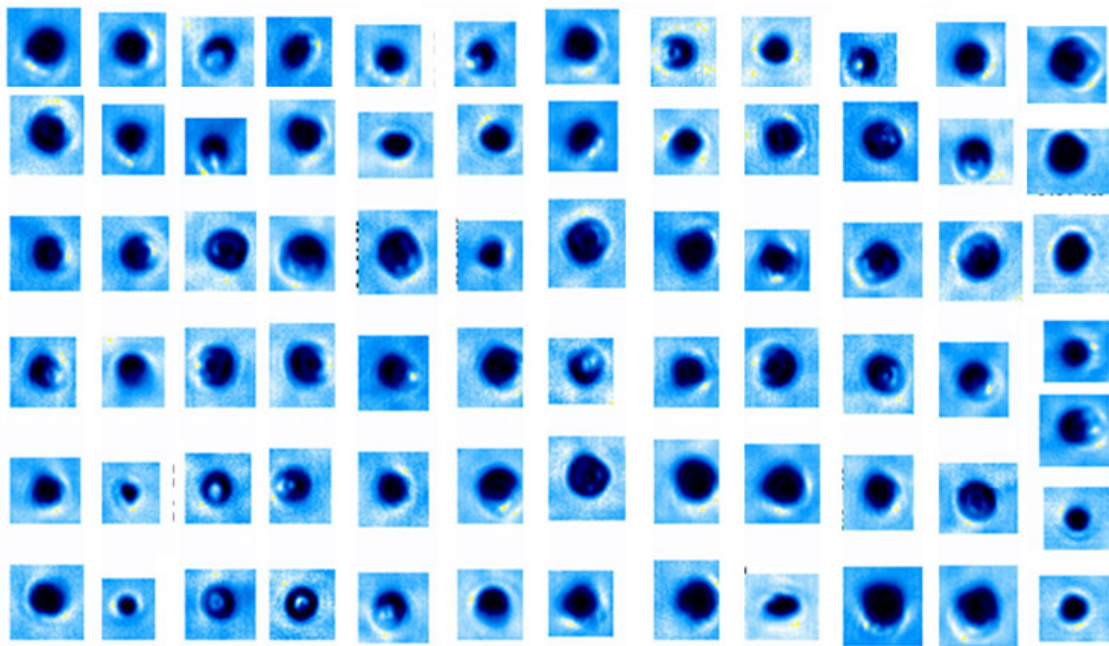
Stereo Pairs



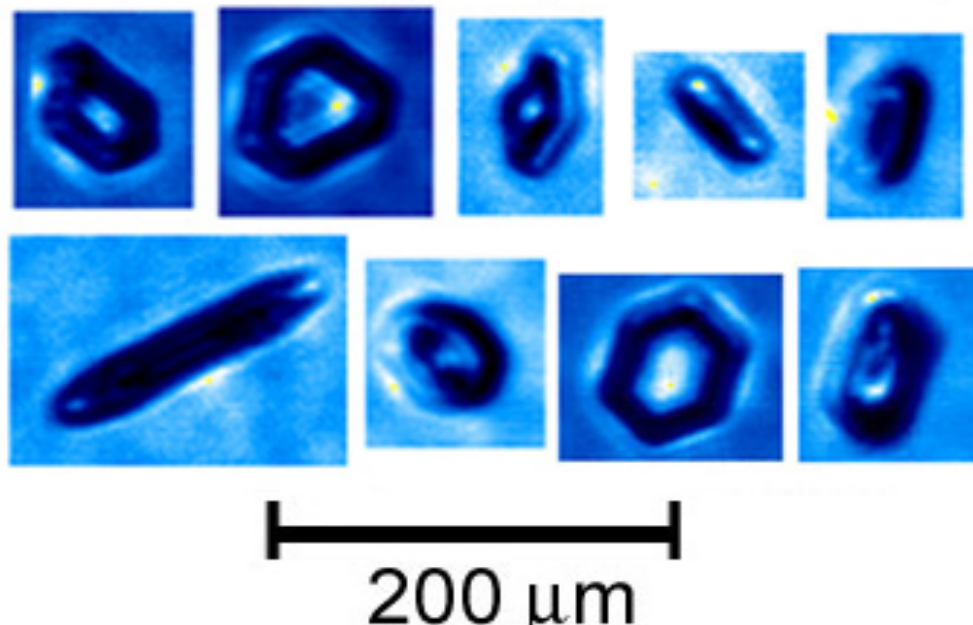
CPI Images in SVC $> 65\ \mu\text{m}$



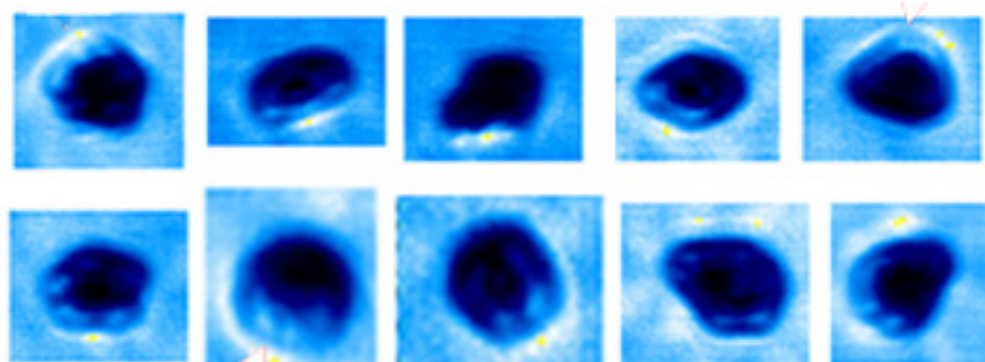
CPI Images in SVC $\leq 65\ \mu\text{m}$



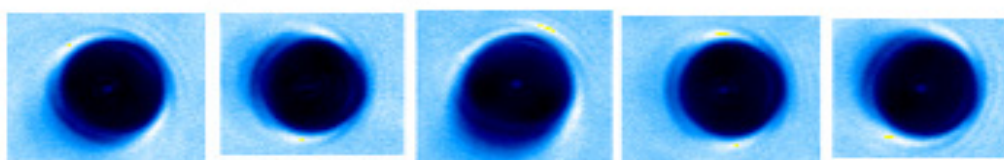
Examples of CPI Images of Plate-like Crystals showing Crystal Edges (Prism Face)

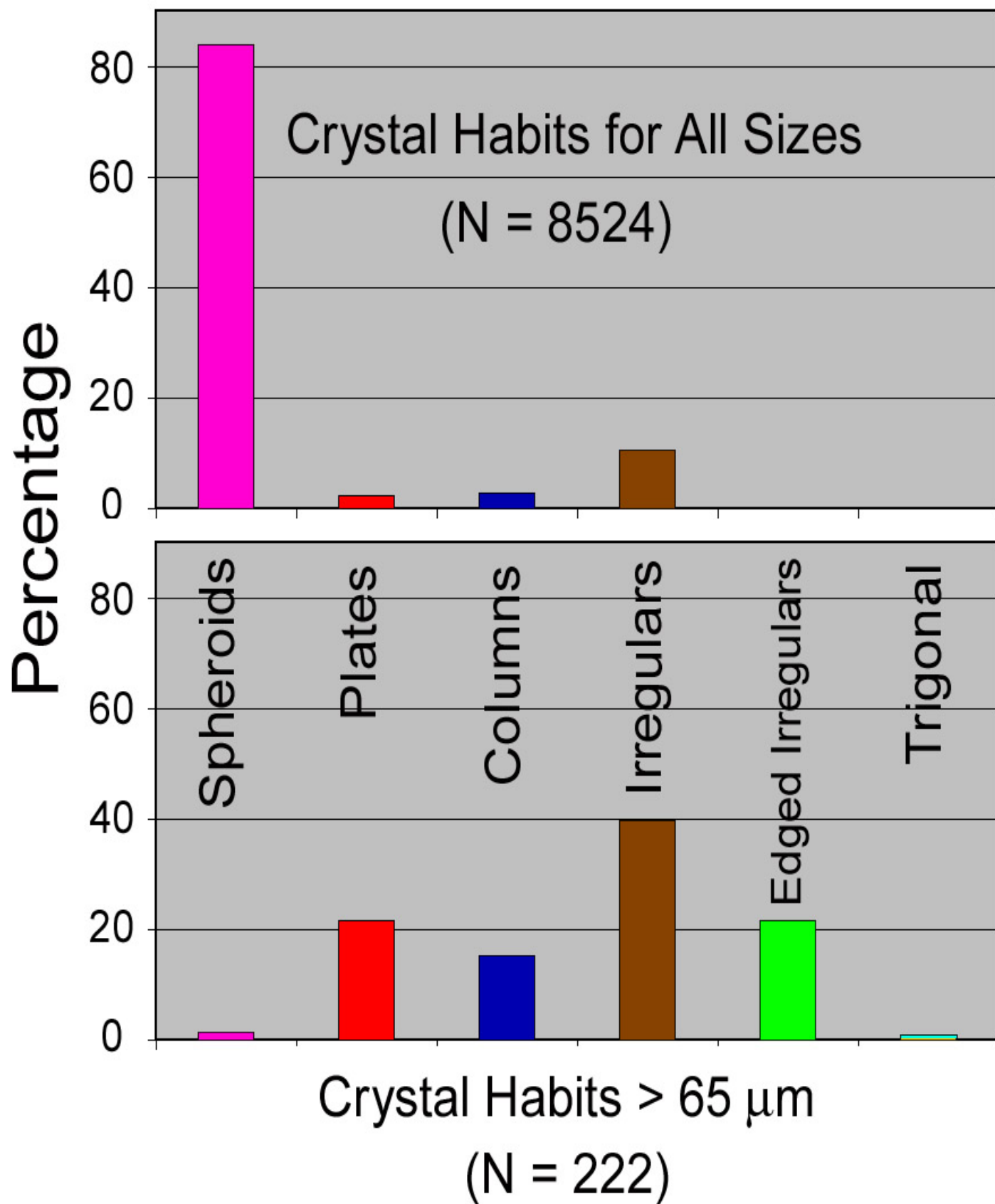


Examples of Edges on CPI Images of Irregular Crystals



Examples of Glass Beads Imaged by CPI in the Lab

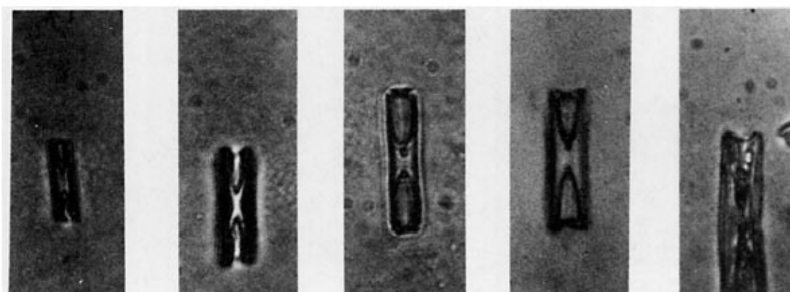
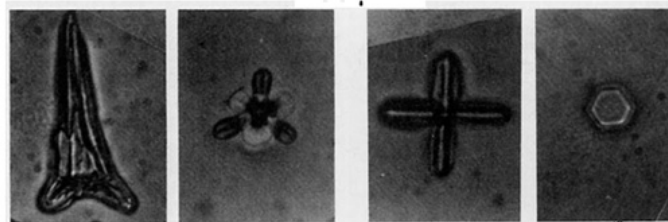
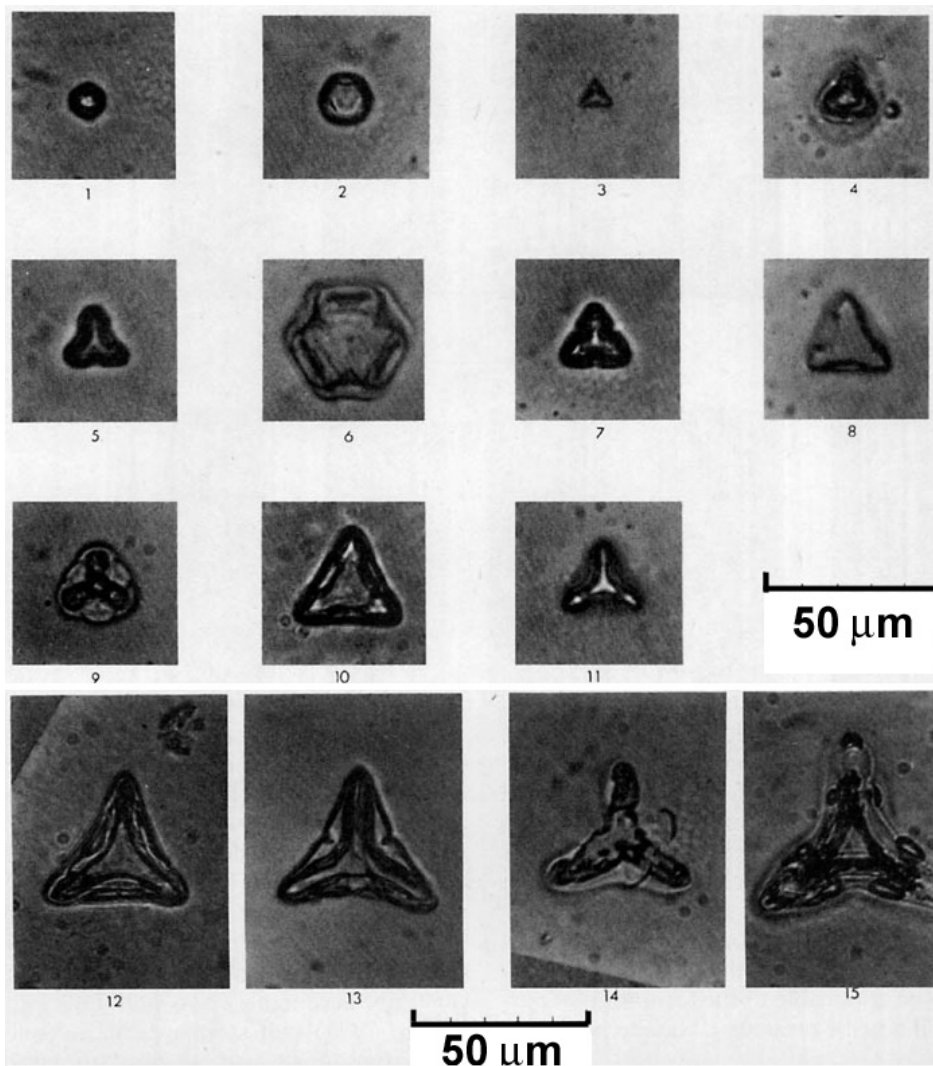


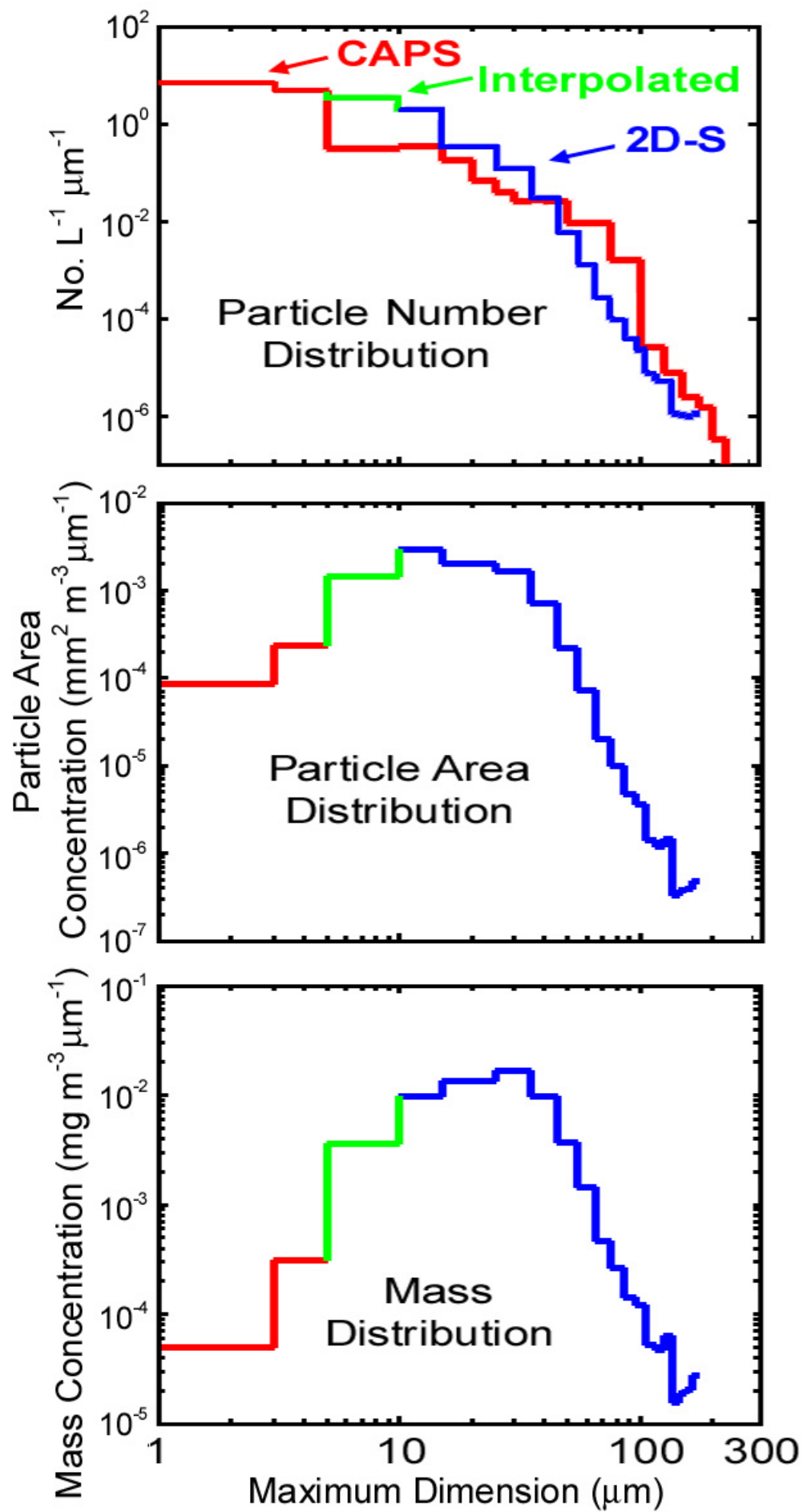


Particle Shapes Observed in SVC CR-AVE Crystals Differ from those Observed at -84°C near Kwajalein by Heymsfield in 1973

- **The only other images of ice particles in TTL SVC are from Heymsfield WB-57F Replicator Data, who found that the Ice Particles were $\leq 50\ \mu\text{m}$, with shapes “... a 50% Mixture of Trigonal Plates and Columns” “... a few Polycrystals and Plates were also Observed.”**
- **Present study finds TTL SVC to contain mostly spheroidal and plate-like crystals 0.5 to $165\ \mu\text{m}$.**
- **No water vapor or chemistry measurements in 1973. Mixed organics and sulfate aerosols, and (apparently) very high water vapor in TTL during CR-AVE.**

Replicator Images Taken in 1973 at -84°C near the Kwajalein Atoll (Heymsfield 1986)





	Mean	σ	Max	Min
Particle Concentration (No. L ⁻¹): WB-57F Simulation	66.0 55	30.8	188.8	22.5
Particle Concentration > 65 μm (No. L ⁻¹)	0.004	0.017	0.08	0.00
<u>R_{eff}</u> (μm): WB-57 Simulation	8.82 7.3	2.44	16.7	5.51
Extinction (km ⁻¹)	0.009	0.011	0.063	0.002
IWC (mg m ⁻³)	0.055	0.098	0.503	0.012

SUMMARY

- **SVC frequently observed around Costa Rica in 500 to 1,000 m layers from FL530 to FL580 (-75°C to -85°C)**
- **Particle shapes are largely quasi-spherical until size exceeds about 65 μm , then plates (and possibly some columns) are observed, compared with small trigonal and columnar crystals seen by Heymsfield (1973) near Kwajalein.**
- **Model results (Jensen et al. 2007) predict $\text{RH}_{\text{ice}} > 175\%$ ($> 2.5 \text{ ppm}$) required to grow the large particles observed during CR-AVE.**